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Two current approaches to science in early education : the physical-knowledge approach by Kamii and DeVries and the science education approach by Diane Dodge

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The primary focus of this paper is to review the characteristics of two science approaches to teaching science to children: the physical-knowledge approach by Kamii and De Vries, and the science education approach by Diane Dodge. Similarities and differences between the two approaches are analyzed. The conclusion of this study found that both approaches emphasize children's active role in learning. However, Kamii and DeVries's physical-knowledge approach emphasizes children's logical reasoning development, while Dodge's science education approach places greater emphasis on content and scientific knowledge.

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Two Current Approaches to Science in Early Education:

The Physical-Knowledge Approach by Kamii and DeVries

and the Science Education Approach by Diane Dodge

A Graduate Research Paper

Submitted to the

Division of Early Childhood Education

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Master of Arts in Education

UNIVERSITY OF NORTHERN IOWA

By

Seon Chun

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Entitled: Two Current Approaches to Science in Early Education:

the Physical-Knowledge Approach by Kamii and DeVries

and the Science Education Approach by Diane Dodge

has been approved as meeting the research paper requirements for the Degree of Master of Arts in Education.

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Abstract

The primary focus of this paper is to review the characteristics of two science approaches to teaching science to children: the physical-knowledge approach by Kamii and DeVries and the science education approach by Diane Dodge. Similarities and differences between the two approaches are analyzed. The conclusion of this study found both approach emphasize on children's active role in learning. However, Kamii and DeVries's physical-knowledge approach emphasizes children's logical reasoning development, and Dodge's science education approach places greater emphasis on content and scientific knowledge.

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CHAPTER I

INTRODUCTION

We live in a time when science deeply affects our lives. It may not be an exaggeration that the history of human progress is the developmental history of science. We have just a few months before entry into a new millenium, and I think everybody can agree we will see many changes in both science and education in the 21st century. A challenge for early educators is how to develop thinking processes in children who will live in a century where new technologies will be commonplace.

This paper reviews two approaches to science in early education. The first one is the constructivist physical-knowledge approach by Kamii and DeVries (1978/1993), and the other is the science education component of the Constructing Curriculum for the Primary Grades developed by Diane Dodge, Judy Jablon, and Tony Bickart (1994).

History of the Approaches Studied

Prior to the 1960s the emphasis in science teaching at all levels was on the product or content (Cain & Evans, 1984). This involved the rote learning of facts to be tested later. In more recent years, there has been a change to an emphasis on the process. This is clearly evidenced by the number of current science curricula ascribing to "discovery learning," the "hands-on" approach, and "concrete experiences" (Balding & Richards, 1980). The change in emphasis can be attributed to the development of understanding about how children learn and their stages of cognitive development (Cain & Evans, 1984). The process emphasis engages and encourages children to be active in their own learning.

Physical-Knowledge Approach

The physical-knowledge approach was developed by Constance Kamii and Rheta DeVries.

Constance Kamii is Professor at the University of Alabama, Birmingham. Kamii was a colleague of Piaget, and taught at the University of Geneva in Switzerland. In addition, she wrote a book Number in Preschool and Kindergarten in 1982, several other books, and many articles.

Rheta DeVries is director of the Regents' Center for Early Developmental Education and Professor of Curriculum and Instruction at the University of Northern Iowa. Except for experience as a public school teacher, she has been working as a constructivist educator for over 28 years. Formerly, she was on the faculty at the University of Illinois at Chicago Circle, the Merrill-Palmer Institute, and the University of Houston. She wrote a book Constructivist Early Education: Overview and Comparison with Other Programs with Lawrence Kohlberg in 1987. In 1994, Moral Classrooms and Moral Children: Creating a Constructivist Atmosphere in Early Education was published, authored by DeVries and Zan. In addition, she wrote several other books, and many chapters and articles about early childhood education.

In 1970, Kamii and DeVries met when Piaget came to California for a conference on Measurement and Piaget. DeVries was instrumental on obtaining a position for Kamii at the University of Illinois at Chicago where they began to collaborate in about 1971 to develop the educational implications of Piaget's theory. They published their first book, Piaget for Early Education (1975), published in French by the University of Geneva. A second book, Physical Knowledge in Preschool Education: Implications of Piaget's Theory was published in 1978. Beside these books, Kamii and DeVries co-wrote Group Games in Early Education: Implications of Piaget's Theory published in 1980. Piaget himself wrote forewords to the physical-knowledge and group games books. The Missouri Department of Elementary Secondary Education adopted constructivist education in 1987 and Kamii and DeVries have been continuing consultants to their Project Construct (R. DeVries, personal communication, March 25, 1999).

Diane Dodge's Science Program Approach

Diane Trister Dodge is an author with Laura J. Colker of The Creative Curriculum and many other publications. She is founder and current president of Teaching Strategies Incorporated. She has worked with teachers and administrators for 30 years, and from those experiences, she developed curriculum and training materials (1999, February 28, http://teachingstrategies. com). In 1994, she published a book, Constructing Curriculum for the Primary Grades, with Tony Bickart and Judy Jablon. They developed it while Bickart was working in the Washington, DC public schools through a grant that Teaching Strategies received. Recently, the Dallas, Texas public schools have begun the process of adopting it as the curriculum for their first, second, and third grades (D. Dodge and P. Caitlin, personal communication, March 19, 1999).

Purpose of the Study

The purpose of this paper is to review and compare the physical-knowledge activities of Kamii and DeVries's constructivist approach and the science education component of Diane Dodge's Constructing Curriculum for the Primary Grades. To accomplish this purpose, this paper will address the following questions:

1. What are the characteristics of Kamii and DeVries's physical-knowledge approach to science?
2. What are the characteristics of Diane Dodge's approach to science?
3. What are the similarities and differences between the two approaches?

Need for the Study

Science is one of the most effective ways in which children can develop cognitively, socially and emotionally, and physically. That means it is highly important to use an appropriate science program for children's development. Therefore, early educators need to know what kinds of science programs are being used and what the characteristics of each program are. This review may help teachers who are looking for a science program for young children.

Limitations of the Study

This.review considers only two of the many published science programs for young children. These were selected because they represent progressive thinking about science education. To supplement information provided in published sources, the writer interviewed Rheta DeVries, and e-mailed Diane Dodge and her colleague, Caitlin Pike.

CHAPTER II
REVIEW OF LITERATURE

The Physical-Knowledge Approach by Kamii and DeVries

DeVries refers to physical-knowledge activities as part of a larger program she calls "constructivist education," inspired by Piaget's research and theory. The rationale for physical-knowledge activities originated in Piaget's emphasis on the role of action in the development of intelligence in a general sense as well as of knowledge of the physical world.

DeVries and Kohlberg (1990) point out that according to Piaget

> . . . cognitive development progresses with gradual interiorization of action, making it possible for thought without overt action. Since the thought process of preschool children is closely linked to physical action, activities to promote the development of thought must appeal to the children's interest in figuring out how to do things - that is, in physical activities. (p. 92)

Kamii and DeVries based their physical-knowledge approach on distinctions made by Piaget between two kinds of experience: physical experience and logico-mathematical experience from which come two kinds of knowledge (physical knowledge and logico-mathematical knowledge). According to Kamii and DeVries (1978/1993), physical-knowledge is "knowledge of objects which are 'out there' and observable in external reality" (p. 16). Piaget pointed out that the source of physical-knowledge is mainly in the object, that is, in the way the object provides the subject with opportunities for observation. On the other hand, logico-mathematical knowledge "consists of relationships which the subject creates and introduces into or among objects" (Kamii & DeVries, p. 17). The source of logico-mathematical knowledge is in the subject. The child obtains information from objects and, almost at the same time, creates logico-mathematical knowledge from "his action bearing on the objects" (p. 17). Kamii and DeVries state that although Piaget distinguished physical-knowledge and logico-mathematical knowledge, the two types of knowledge are intimately linked. According to Kamii and DeVries, through physical experience, children get knowledge from objects by empirical abstraction. In empirical abstraction, children recognize some certain aspects of an object and ignore others. Unlike empirical abstraction, through reflective abstraction the child constructs logico-mathematical knowledge. Reflective abstraction derives from the subject's action of introducing relationships into or among objects (p. 18). Therefore, through physical-knowledge activities, children construct logico-mathematical knowledge.

Kamii and DeVries (1978/1993) say, "We use physical-knowledge activities not only to enable children to build a foundation for physics and chemistry but also to stimulate them to construct a logical and spatio-temporal framework which will help them to structure many other contents" (p. 27). Physical-knowledge activities offer children possibilities for the kinds of actions on objects by which such knowledge is formed. According to Kamii and DeVries,

> Physical-knowledge activities involve the child's action on and observation of the reactions of objects in the physical world. Actions on objects may derive from the child's desire to see what will happen, from the desire to verify an anticipation of what will

happen, and from systematic experimentation that is a combination of these. In the course of such actions, children have the possibility to construct relations that correspond between actions and reactions, and these gradually evolve over many years into causal, explanatory relations. . . . Physical-knowledge activities are especially conducive not only to the development of children's knowledge of objects in the physical world, but also to the development of their intelligence, or knowledge, in a more general sense. (p. 91)

Types of Physical-Knowledge Activities

Kamii and DeVries (1978/1993) distinguish types of physical knowledge activities based on the relative importance of action and observation:

1. The movement of objects. Activities involving the movement of objects meet the criteria described below in especially satisfactory ways. Actions that can be performed on objects to make them move include pulling, pushing, rolling, kicking, jumping, blowing, sucking, throwing, swinging (a pendulum), twirling, balancing, and dropping. All activities in this category offer the advantage of being good for the structuring of space and logico-mathematical knowledge, in addition to physical knowledge. . . .
2. Changes in objects. These activities are different from those involving the movement of objects in that the phenomena involve actual changes in the objects themselves. For example, cooking, mixing paints or paint powder and water, drying paint, making pottery, melting wax and making candles, and freezing and thawing water are included. In this type of activity, children act on objects, but in

a less directly causal way than in producing an object's movement. That is, the cause of changes in objects is due more to the interaction of the objects themselves than due to the child's action.

3. Activities between the two categories. Between the two categories of movement and changes in objects are many other activities which cannot be categorized as neatly. Examples are: Finding out whether an object sinks or floats, sifting, shadow play, playing with mirrors, producing echoes, looking through a magnifying glass, and touching various objects with a magnet. The above activities share elements with the other two categories but cannot be placed in either of them. The child's actions clearly do not produce a change in the objects themselves; on the other hand, any movement that results from the action is caused more by the properties of the object than by the child's action. (pp. 5-12)

Criteria of Good Physical-Knowledge Activities

Kamii and DeVries (1978/1993) suggest four criteria for good physical-knowledge activities based on the constructivist rationale:

1. The child must be able to produce the movement by his own action. . . . The essence of physical-knowledge activities is the child's action on objects and his observation of the object's reaction. . . . the phenomenon selected is something that the child himself can produce. . . .

2. The child must be able to vary his action. When the variations in the child's action result in corresponding variations of the object's reaction, the child has the opportunity to structure these regularities. . . . Without a direct correspondence

between the variations in actions and reactions, a phenomenon offers little opportunity for structuring.

3. The reaction of the object must be observable. Movement is a clearly observable reaction of an object to the child's action. That is, we stress this first category of activities, the movement of objects, as the best way to facilitate the child's structuring of correspondences. . . .

4. The reaction of the object must be immediate. Correspondences are much easier to establish when the object's reaction is immediate. (pp. 8-9)

The Role of Children

The general objectives of physical-knowledge activities are to inspire children's development and autonomy. In Piaget's theory, knowledge develops through action, and therefore, in a constructivist program, children are encouraged to be active. The following are more specific roles.

First of all, children in physical-knowledge activities are observers. After acting on objects, children observe carefully how the objects react. In contrast to traditional education where children play more passive roles, children in constructivist classrooms are active. If children hear abstractly about the results of actions instead of observing the reactions of objects empirically, they are likely not to understand and will lose interest.

Second, children in physical-knowledge activities are the initiators. In activities involving the movement of objects, children make objects move. Through active and careful observation, children find problems and start to ask questions. Those problems and questions motivate children's new actions on objects. Children initiate the activities that they want to explore in addition to activities suggested by the teacher.

Third, children in physical-knowledge activities are the constructors of knowledge. Through acting on objects by empirical and reflective abstraction, children think actively and create relationships. Such relationships provides the framework in knowledge and understanding.

It is difficult to separate the roles of children in physical-knowledge activities. Those roles are conveyed as one integrated series by children's actions.

The Role of the Teacher

In the physical-knowledge approach, the teacher's objective is for children to pursue the problems and questions they come up with and that teachers suggest. Kamii and DeVries (1978/1993) suggest principles of teaching related to planning, beginning, continuing, and following up the activity. These are summarized below,

1. Planning the activity

   Kamii and DeVries point out that four ways of acting on objects suggest four types of questions a teacher might ask children.

   - Acting on objects and seeing how they react. Children act on objects without any clear intention. Children observe the reactions of objects. That is the beginning of physical-knowledge activity. Kamii and DeVries suggest questions such as "What can you do with these?" or "Think of whatever you can do with these that's interesting" (p. 48).
   - Acting on objects to produce a desired effect. The teacher encourages purposeful experimentation by asking, "Can you do *X*?"

- Becoming aware of how one produced the desired effect. Kamii and DeVries note when children have become successful in producing certain physical phenomena, the teacher may plan interventions to help them become more conscious of what they are doing and to experiment more consciously by deliberately varying their action. The question that teachers can use is, "How did you do it?"
- Explaining causes. Kamii and DeVries state “Explanations of most phenomena are, in fact, impossible for preschool children” (p. 50). Asking young children for an explanation is generally fruitless and produces answers such as, “The water came down because it wanted to."

2. Beginning the activity
   - Principle I: Introduce the activity in a way that maximizes children’s initiative.
   - Principle II: Begin with parallel play. In parallel play, young children can experiment with objects, and this initiative is exactly what we want to encourage.
3. Continuing the activity
   - Principle I: Figure out what the child is thinking and respond sparingly in his terms.
   - Principle II : Encourage children to interact with other children. To do this, the teacher can ask four types of questions involving prediction, producing a desired effect, becoming aware of how one produced a desired effect, and explaining causes.

- Principle III: Integrate all aspects of development in physical-knowledge activities. In physical-knowledge activities, social and moral development, language development, symbolization, and intellectual development are increased.

4. After an activity

- Help children to reflect on what they did, what they found out, and how they produced a desired effect.

Kamii and DeVries (1978/1993) give detailed examples of some physical-knowledge activities that teachers can use in their classrooms. Each activity addresses planning the activity, trying the activity, evaluation, and follow-up. Kamii and DeVries introduce activities such as rollers, inclines, the pendulum, and water-play. Descriptions and transcripts provide real examples that make us imagine how the activity will be.

A shortcoming of Kamii and DeVries's book on physical-knowledge activities is that they describe activities that were done only once. In a new book, DeVries provides examples of how physical-knowledge activities may be done many times over a period of time in order to show how the children's thinking progresses (R. DeVries, personal communication, April 12, 1999).

The Science Education of Diane Dodge

Dodge, Jablon, and Bickart (1994) think the core of the science curriculum in the primary grades is "nurturing children's sense of wonder - their interest and excitement in finding out about the world" (p. 355). They focus on teaching children how to think like scientists because young children want to touch, manipulate, look, and listen, and through these actions, young children create explanations about how the natural and physical world works. Coinciding with this idea, they believe that science instruction should build on those natural enthusiasms to seek explanations and answers to questions through active investigation.

Like other areas, their science curriculum is also based on Piaget's theory of cognitive development, developmentally appropriate practice (Bredekamp &Copple, 1997), and several other learning theories. Along with Jean Piaget's work, Erik Erikson's stages of socio-emotional development, and "accepted theories of how children learn best" are mentioned as the basic philosophies of the curriculum (1999, February 28, http://www.teachingstrategies. com).

The Four Categories of Scientific Knowledge

Dodge et al. (1994) classify scientific knowledge into four broad categories. Each category includes science concepts for the primary grades and some topics that teachers can use. The four categories of scientific knowledge are:

1. Living things: the body of knowledge that includes big ideas such as behavior, needs of plants and animals, characteristics, habitats, and life cycles.
2. Earth and space: the body of knowledge related to day and night, the moon and the stars, climate and weather, and the surface of the earth.
3. Matter: the body of knowledge that includes the properties of substances and the relationship of the substance's properties to its purpose.
4. Energy: the body of knowledge regarding light, sound, heat, motion, and electricity. (p. 365)

Dodge et al. (1994) insist that these four categories of knowledge should be taught to primary grade children. In their view, children need to study topics that allow them to do extensive research over time. They note that while the science curriculum determines the content to be explored and the general topic children might investigate, there should be room to include the child's special interests as well.

Using Science Skills

Bickart, Dodge, and Jablon (1997) suggest that children can learn science skills as they investigate topics of interest. These skills are the following:

1. Asking questions. Like real scientists, children begin any scientific inquiry by asking questions. If children initiate questions, the teacher might use those questions to design an experience and environment that children can investigate.
2. Making predictions. Children predict some phenomena based on their prior knowledge. In other words, children use their own experiences to predict the results of a experiment.
3. Observing with increasing attention to detail. Teachers can encourage children to use their senses to observe in various ways. The more children observe, the more they become good observers. Dodge et al. (1994) emphasize the importance of sensory observation (p. 94)
4. Setting up experiments. For investigating their questions, children actually do experiments. At this point, children guess what is an appropriate experiment and discuss what kinds of tools they need.
5. Interpreting data and drawing conclusions. Through careful experimentation, children get some results. Thereafter, children interpret the results and make

conclusions. Bickart, Dodge, and Jablon suggest some questions for encouraging children in this process, "Why is this happening?," "What does the evidence show?," "What do you think happened during the experiment?," "What did we find out?," or "What new questions do we have now?" (p. 95).

6. Communicating findings. After making conclusions, children share and discuss their discoveries like real scientists. For effective communication, children may make drawings, charts, graphs, and presentations.

The Role of Children

The major role of children in Dodge's program is to learn to think like scientists. Dodge et al. (1994) think that through the environment which teachers prepare for promoting the skills of scientific inquiry, children recognize scientific questions in their everyday world. In Dodge's program, "Children are encouraged to ask questions, make predictions, set up experiments, test explanations, and describe and revise conclusions. Children will make discoveries and gain understanding through active and purposeful investigation." (Dodge et al., p. 357)

In addition, children in Dodge's science program are organizers and presenters. After getting results of activities, children share their ideas and discoveries verbally and non-verbally. For doing this, children need to organize and present their findings. Dodge et al. (1994) think that for effective organizing, children can make documentation, drawings, charts, and other presenting materials. Through this process, children can improve their communication skills and logical thinking.

The Role of the Teachers

In Dodge's program, the teachers set up learning experiences that stimulate children's natural curiosity. They give children opportunities to use the process skills of scientific inquiry to solve problems and devise explanations. As mentioned above, Dodge et al. (1994) believe that science is not a subject that should happen only once or twice a week. "Children can learn to think like scientists and recognize scientific questions in their everyday world when teachers use daily experiences to promote the skills of scientific inquiry" (p. 370). Dodge et al. (1994) suggest that the teacher's main role is to make science a part of everyday life in the following ways:

1. Provide space and materials to encourage science exploration. Teachers can make a classroom a laboratory for questioning, observing, predicting, and explaining. Teachers identify an area that is separated from any other areas for science investigation. Then teachers provide various tools for scientific investigations, create an invention center, provide a variety of interesting collections, and include living things in the classroom.
2. Model scientific thinking. Teachers can share observations with children, encourage children to share, and respond scientifically to problems so as to model scientific thinking. Dodge believes that through these experiences, children will be more likely to think like scientists.
3. Respond to events in the environment. Teachers can use the geographical location of a school for science class. For example, the construction or demolition of a local building, the change of seasons, or a classroom pet becoming sick can be good scientific inquiries.

The teachers in Dodge's program select topics that encourage children to engage in the science process and lead them to increase their understanding of science. The topics should be based on the teacher's and children's interests, availability of resources, opportunities for first-hand research, and linkages to other subjects for integrating curriculum. Dodge et al. (1994) say we need to remember that science content will vary from classroom to classroom depending on the age of the children and their prior experiences, the immediate environment of the school, and the interests of children and their teachers.

As mentioned above, Dodge et al. (1994) suggest four categories of scientific knowledge. More specific topics are ourselves, pets, gardens, habitants, baby to adult, day and night, the moon and its changes, condensation and evaporation, recycling and garbage, gases, and light and shadows.

CHAPTER III

SIMILARITIES AND DIFFERENCES BETWEEN KAMII AND DEVRIES'S CONSTRUCTIVIST PHYSICAL-KNOWLEDGE APPROACH AND DODGE'S SCIENCE EDUCATION APPROACH

In Chapter II, I reviewed the characteristics of the constructivist physical-knowledge approach by Constance Kamii and Rheta DeVries and the science education component of Constructing Curriculum developed by Diane Dodge, Judy Jablon, and Tony Bickart. Regarding those characteristics, I will address some similarities and differences between the two approaches.

Similarities

As I mentioned before, the two programs reflect progressive thinking in science. That commonality directly leads to some similarities in the two programs. The similarities are as follows:

1. Children are active. Authors of both programs agree that children have natural curiosity. Children ask questions and try to solve the questions by themselves and through interacting with teachers or peers without any external force. In addition, children act on and experiment directly with objects.
2. Children's interest is necessary. Both programs emphasize children's interest. Teachers in both programs choose topics that are related to children's experiences and environments for fostering children's interest.
3. Children construct knowledge. Both programs respect Piaget's idea that knowledge is gained only through an active constructive process. Both programs are based on

Piaget's theory. In addition, both programs agree that each child assimilates information and constructs knowledge differently according to their prior experiences. Moreover, when solving a problem, children interpret and react based on their experience. This indicates that teachers need to provide lots of experiences with objects for children.

4. Materials and activities should be appropriate to children's levels of development. In both programs, when teachers choose materials, they consider children' abilities.
5. Teachers focus on children's questions. Both programs emphasize that children can initiate questions based on their interests. When children have questions, the teachers of both programs support children in expanding their ideas. That means that according to children's questions, teachers change their curriculum and activity.
6. Teachers intervene in similar ways. Both programs require teachers to ask open-ended questions that stimulate children's thinking. By introducing materials and asking questions teachers intervene to trigger children's curiosity. The teachers of both programs create an atmosphere in which children can explore and think freely, also.
7. Science is as everyday part of the curriculum. Both programs require teachers to make science a part of their regular curriculum. For conveying this objective, teachers set a science area in the classroom and provide various materials everyday.
8. Factors are varied systematically. Both programs emphasize the importance of systematically varying factors in order to enable children to consider causal variables. However, with young children, the teacher in physical-knowledge activities plans materials so as to control factors for children, whereas older children in the Dodge program are expected to understand the necessity for a "fair test."

Differences

While the two programs have some similarities as mentioned above, I also found some differences:

1. Objectives are very different. Dodge et al. try to investigate to both content and process. Dodge et al. (1994) state, "The skill of prediction is taught. . .in the context of formal science experiences" (p. 361). In contrast, Kamii and DeVries take the more general and more developmental objective of promoting reasoning and intelligence as well as knowledge. In the Kamii and DeVries (1978/1993) approach, children do learn about properties of objects and about the phenomena of the physical world. They regard content as important, but secondary. Development is the main goal, unlike Dodge's more traditional emphasis on content.
2. The opinion on error is different. The two programs view the role of error differently. Kamii and DeVries award importance to making errors. According to Piaget, children learn from restructuring their knowledge through a process of making errors and reexamining and correcting them. Physical-knowledge activities put more emphasis on the process by which children interact with objects than on the content. In the example with crystals Kamii and DeVries (1978/1993) say the purpose of a crystal-making activity for 4-year-olds is to "stimulate various ideas within a total atmosphere of experimentation" (p. 5). In contrast, in the science education approach, the teacher's more traditional objective is for the child to learn about crystals. Dodge et al. (1994) believe that to make children scientific investigators is to teach them how to find answers to questions. It implies that if the teacher teaches how, children will

know the essential. They focus on the children's role as seeking explanations and the right answers, not the wrong answers.

3. Style of answers and questions is different. Kamii and DeVries (1978/1993) encourage the teacher to ask open-ended questions and guide them as they experiment with objects. In Dodge's program, teachers ask open-ended questions, but sometimes explain directly in a more traditional way to answer the children's questions. Dodge et al. (1994) use the lesson of the earthworm as an example. When children are curious about why earthworms will not be still, the teachers respond, ". . . the tickling comes from the bristles on the worm" (p. 356). In the physical-knowledge approach, the teacher would ask children why they tickle and suggest ways the children can find the answers, such as using a microscope.
4. Suggested contents are different. Some topics are the same, but where differences exist, these are significant. Dodge et al. (1994) propose topics such as light, energy, condensation and evaporation, and gases which Kamii and DeVries (1978/1993) would avoid because these do not meet their criteria of good physical-knowledge activities (That is, the observability of object's reaction). Both programs include shadow activities. In the physical-knowledge approach, shadow activities obviously use light, but do not teach about light. However, Dodge et al. want the children to know about light. In addition, Dodge et al. recommend that children avoid contractions to observe the moon's changes. Because while DeVries (personal communication, March 14, 1999) points out that "There is no harm in children's noticing the phase changes in the moon, but young children usually do not understand that the different phases are all same moon. It is a phenomenon that children can

wonder about, but we would not expect young children to he able to understand the phases of the moon." This difference applies only to the youngest children served by the Dodge et al.'s program. DeVries (personal communication, May 5, 1999) comments that these topics may certainly be appropriate for older primary children who can think about non-observable. However, she cautions that even with older children, the teacher needs to be on the lookout for children who do not understand these phenomena. It is not clear that Dodge et al. limit the presentation of non-observable phenomena to older primary children. The Dodge et al. objective of learning that "The changing position of the sun. . . " (p. 367) may not be appropriate for children before the age of nine years. In her research on children's conception of shadows, DeVries (personal communication, May 5, 1999) found that one 8-year-old was completely confused about a classroom lesson on night and day in relation to positions of earth, moon, and sun.

5. <u>Emphasis on communication of what has been learned is different</u>. After doing the activities, Dodge et al. (1994) suggest integrating literacy by recording children's observations by drawing charts, graphs, and encouraging children to make presentations on what they have done. Although after physical-knowledge activities, the teacher may make a chart with children, Kamii and DeVries (1978/1993) do not emphasize presentation of results. However, constructivist teachers often integrate literacy in physical-knowledge activities by making lists of "What we have learned about ramps," for example, and by making books of photographs and writing down children's dictations about the photographs. Again, DeVries (personal

communication, May 5, 1999) says the presentation of results is an appropriate expectation for primary children.

6. There is a difference in parents' roles in science education. Dodge et al. (1994) encourage parents to talk about scientific events that occur in the home, display interest in science to the child, ask open-ended questions, and provide scientific materials such as books, videos, equipment, etc., in the home. While DeVries agrees that the parent role can be very important, she has not developed this aspect of the constructivist program (R. DeVries, personal communication, April 12, 1990).
7. The use of the scientific method is somewhat different. Dodge et al. (1994) emphasize thinking like a scientist when teaching science to children. They mention "skills of scientific inquiry" while in both programs children question, hypothesize, observe, experiment, interpret data, and draw conclusions. However, in Dodge's approach these are more formalized steps. These steps are the traditional ones that scientists use.
8. There is a difference in extent of program description. Kamii and DeVries (1978/1993) provide a much fuller description of their program with many detailed examples and transcripts of classroom actions and interactions. Dodge et al. (1994) give no transcripts of suggested activities, and descriptions of activities are general.
9. The roles of action and the senses are different. In the view of Kamii and DeVries (1978/1993), children get physical-knowledge primarily through interacting with objects. That implies children give actions to the object – directly or indirectly. Kamii and DeVries explain the meanings of action as physical and mental action used by Piaget. They say children's mental activity guides children's physical action.

Therefore, the two meanings of action are interrelated. In contrast, Dodge et al. (1994) say children primarily get science knowledge through sensing – looking, touching, listening, smelling, and tasting. They state, "From birth, we use our senses to learn about the world around us." (p. 361) Using senses means accepting an external stimulus. Children can use senses without using their brain, like mindless way.

10. The use of "why" questions is different. Kamii and DeVries (1978/1993) consider four types of questions: (a) "Acting on objects and seeing how they react," such as "What do you think will happen if you do X?"; (b) "Acting on objects to produce a desired effect," such as "Can you do X?"; (c) "Becoming aware of how one produced the desired effect," such as "How did you do X?"; and (d) "Explaining causes," such as "Why does X happen?" (pp. 55-56) They add that the first three types of questions are the best for young children, and the "why" type of question is rarely asked except when the teacher wants to call children's attention to something or to figure out what children think. On the contrary, Dodge et al. (1994) regard "why" questions are to lead to a meaningful investigation. They give as examples "Why do seasons change?," "Why is there a filter in the aquarium?" They say these questions ". . . lead to an interesting discussion and much speculation, but not directly to an investigation." (p. 360)

11. The emphasis on sorting and classification is different. Dodge et al. (1994) believe that when children learn the science area that related with collecting activity, "Children can be inspired to sort and classify objects." (p. 372) DeVries and Kohlberg (1987/1990) state "Kamii-DeVries do not regard classification as the most important goal in activities justified (partly) in terms of classification." (p. 72) Although Kamii

and DeVries do not recommend classification activities for the sake of classification, they agree it is important for children to distinguish similarities and differences in objects. Moreover, they suggest how teachers can encourage children's classificatory reasoning. Kamii and DeVries do not recommend sorting activities.

12. The emphasis on life sciences is different. Dodge et al (1994) give many examples of activities involving life sciences. While DeVries (personal communication, May 5, 1999) notes that such activities are common in constructivist classrooms, she has not written about this curriculum component.

In summary, in many ways, Dodge's approach is more traditional in its emphasis on the content of scientific knowledge.

CHAPTER IV
SUMMARY AND CONCLUSIONS

The purpose of this study was to analyze two science approaches in early education – the physical-knowledge activities of Kamii and DeVries's constructivist approach and the science component of Diane Dodge's Constructing Curriculum. The characteristics of the programs were described, and the similarities and differences were discussed.

Both approaches emphasize children's active role, children's interest, children's constructing knowledge, respecting and emphasizing children's experience, children's questions, the teacher's active role as questioner and provider of materials, and making science an everyday part of the curriculum. Nevertheless, there are some differences between both programs. On the objectives of two programs, Kamii and DeVries are interested in developing reasoning, in contrast Dodge et al. focus on content of science. On opinion on error, Kamii and DeVries put importance in making errors on the way to reach right answers, but Dodge et al. want children to learn the right answers right away. On style of answers and questions, Kamii and DeVries support using open-ended questions, but Dodge et al. sometimes use narrow questions although they use open-ended questions as well. On suggested contents, Kamii and DeVries limit the topics to observable object's reactions, but Dodge et al. include abstract topics. On the emphasis on communication, Dodge et al. suggest presenting the result of activities using charts and graphs. On the parent's role, Dodge et al. encourage parents to participate in science education, but while DeVries agrees this is important, she and her colleagues have not written about this. On the use of the scientific method, Dodge et al. use more formalized steps that the scientist traditionally does, Kamii and DeVries do follow the scientific method in so far as it is appropriate for young children but in less formalized ways. On the extent of program description, Kamii and DeVries provide many detailed transcriptions of activities, but Dodge et al. do not. On the roles of action and the senses, Kamii and DeVries give more emphasis on action unlike Dodge et al. who consider senses as more important. On the use of 'why' questions, Kamii and DeVries are careful in using 'why' questions, whereas, Dodge et al. regard 'why' questions as a primary strategy. On the emphasis on sorting and classification, Dodge et al. suggest activities to sort and classify objects unlike Kamii and DeVries who do not recommend sorting activities. And on the emphasis on life science, Dodge et al, give many examples related with life sciences while DeVries agrees this is an essential part of an early childhood science program, she and her colleagues have not dealt with this aspect of science.

While both programs were said to be based on Piaget's theory of cognitive development, the physical-knowledge approach by Kamii and DeVries draws more specifically and extensively from this theory. The science education approach of Diane Dodge is a more traditional program that focuses on teaching children how to think like scientists.

REFERENCES

Balding, G., & Richards, N. (1980). Springboards ideas for science. Melbourne: Nelson.

Bentley, M. L. (1995). US science education: Prospects for reform. Australian Science Teachers Journal, 41 (3), 20-27.

Bickart, T. S., Dodge, D. T., & Jablon, J. R. (1997). What every parent needs to know about 1st, 2nd, & 3rd grades: An essential guide to your child's education. Washington, DC: Co-published by Teaching Strategies and Sourcebooks, Inc.

Bredekamp, S., & Coppel, C. (Eds.). (1997). Developmentally appropriate practice in early childhood programs (Rev. ed.). Washington, DC: National Association for the Education of Young Children.

Cain, S. E., & Evans, J. M. (1984). Sciencing. Columbus, Ohio: Merrill.

Carin, A. A. (1993). Teaching modern science (6^{th} ed.). Columbus, OH: Merrill Publishing Company.

Chaillé, C., & Britain, L. (1996). The young child as scientist: A constructivist approach to early childhood science education (2nd ed.). New York: Longman.

DeVries, R., & Kohlberg, L. (1987/1990). Constructivist early education: Overview and comparison with other programs. Washington, DC: National Association for the Education of Young Children.

Dodge, D. T., & Colker, L. J. (1992). The creative curriculum for early childhood (3rd ed.). Washington, DC: Creative Associates, Inc.

Dodge, D. T., Jablon, J. R., & Bickart, T. S. (1994). Constructing curriculum for primary grades. Washington, DC: Teaching Strategies, Inc.

Elliott, S. (1989). Science for young children. Australian Early Childhood resource booklets, no. 1. Watson: Australian Early Childhood Association, Inc.

Kamii, C., & DeVries, R. (1993). Physical knowledge in preschool education: Implications of Piaget's theory. New York: Teachers College Press. (Original work published 1978)

Kavaz, L. (1997). Why don't they understand us? Science and Education, 6, 263-272.

Laevers, F. (1993). Deep level learning: An explanatory application on the are of physical knowledge. European Early Childhood Education Research Journal, 1, 53-68.

Lind, K. K. (1997). Science in the developmentally appropriate integrated curriculum. In C. H. Hand, D. C. Burts & R, Charlesworth (Eds.), Integrated curriculum and developmentally appropriate practice: Birth to age eight (pp. 75-101). New York: State University of New York Press.

Lind, K. K. (1998, February). Science in early childhood: Developing and acquiring fundamental concepts and skills. Paper presented at the Forum on Early Childhood Science, Mathematics, and Technology Education, Washington, DC. (ERIC Document Reproduction Service No. ED 418 777)

Teaching Strategies Inc. (1999, February 28). The Creative Curriculum for early childhood: Introduction [30 paragraphs]. What distinguishes the Creative Curriculum from other approaches? [on-line]. Available: http://www.teachingstrategies.com/...reas/ED_CCFAQ.html&Userid=1014960

Teaching Strategies Inc. (1999, February 28). Teaching Strategies' 1998 conference presenters [5 paragraphs]. Diane Trister Dodge [on-line]. Available: http://www.teachingstrategies.com/educators/ED_staffdev/Ed_confbios.html